ASI Asia Social Issues ASIA SOCIAL ISSUES 2025; 18(6): 283180
https://doi.org/10.48048/asi.2025.283180 RESEARCH ARTICLE

A Literature Review and Case Analysis of Nature-Based Healing and Multisensory Digital Technology in Open-Plan Office Spaces

Shijie Wu and Atithep Chaetnalao*

Faculty of Decorative Arts, Silpakorn University, Nakhon Pathom 73000, Thailand

(*Corresponding author's e-mail: chaetnalao@hotmail.com)

Received: 23 March 2025, Revised: 20 May 2025, Accepted: 26 May 2025, Published: 1 July 2025

Abstract

This paper adopts a combination of systematic literature review and comparative case analysis to explore the integration mechanism and application benefits of nature-based healing concepts and multisensory digital technology in open-plan office design. First, the study constructs a theoretical framework centered on "technology-experience-culture". It systematically reviews improve the intrinsic mechanisms by which nature-based healing and multisensory interaction employees' mental health, restore attention, and stimulate creativity. Second, through a comparative analysis of typical cases such as virtual reality immersion experiences, dynamic lighting control, natural element integration, restorative space design, and biophilic design, the paper reveals the complementary relationship between digital technology and physical natural elements in spatial design. It also identifies the respective challenges of data privacy, ethical risks, and technical feasibility in achieving sensory coherence, emotional adjustment, and cultural adaptation. The research found the positive impact of natural healing and multi-sensory digital technology on optimizing the office environment. Also, they provided a theoretical basis and practical inspiration for future research on intelligent sensory interaction and personalized space adaptation. This study aims to promote a higher level of interdisciplinary integration in open-plan office design and lay a solid foundation for subsequent empirical research.

Keywords: Open-plan office space, Nature-based healing, Multisensory digital technology, Mixed-methods analysis

Introduction

The problem

With the rapid acceleration of global urbanization, a significant portion of the population has become concentrated in metropolitan areas, leading to a growing scarcity of direct contact with nature. This detachment from nature has, weakened psychological resilience and cognitive recovery abilities (Organization, 2024) . At the same time, open-plan office spaces, designed to enhance teamwork and work efficiency, have been widely adopted worldwide (Chulvi et al., 2020; Wen et al., 2024). While this design optimizes information flow and communication, it also inevitably introduces challenges such as noise distractions, a lack of privacy, and environmental monotony. These factors negatively impact employees' concentration, emotional stability, and job satisfaction (Felgueiras et al., 2023; Niza et al., 2024). Moreover, in high-density urban settings, office workers often experience prolonged exposure to stressful conditions, leading to increased mental fatigue and psychological strain. Thus, effective design interventions are urgently needed to restore psychological balance and enhance work performance.

Theoretical background

The relationship between humans and the natural environment is long-standing and complex, with the Biophilia Hypothesis revealing humans' innate physiological and psychological need for natural elements (Wilson, 1984). Designers have gradually introduced nature-based healing into office environments in response to these practical needs. Its core principle is to activate the body's intrinsic

restorative mechanisms by incorporating elements such as plants, water features, and natural light, thereby reducing stress levels, improving emotional states, and enhancing cognitive function (Doherty et al., 2024; Liu et al., 2022). At the same time, the rapid development of digital media technology has provided technical support for creating immersive virtual natural environments. Through the use of virtual reality (VR), augmented reality (AR), and other multisensory interactive technologies, designers can simulate realistic natural scenes within limited indoor spaces, extending traditional nature therapy into the digital realm (Browning et al., 2020; Frost et al., 2022). This digital nature experience transcends the physical constraints of space and offers a novel intervention for alleviating the psychological stress experienced by urban office workers (Arpaia et al., 2022; Yeung et al., 2021).

Research gap

However, in practice, achieving the organic integration of nature-based healing and multisensory digital technology while fulfilling employees' intrinsic need for natural experiences and mitigating potential risks such as technology overuse and sensory overload remains a significant design and application challenge. Iindividuals' perceptions of natural elements vary considerably in cross-cultural contexts, posing higher demands on design solutions' cultural adaptability and technical feasibility (Pollmann et al., 2023).

Research objective

This study aims to develop a theoretical framework for integrating nature-based healing and multisensory digital technology in open-plan office spaces through a systematic literature review and comparative case analysis. It seeks to:

1. Clarify the mechanisms these approaches contribute to employee mental health, cognitive recovery, and creativity enhancement.

2. Address key challenges such as data privacy, ethical responsibility, and cultural adaptation.

3. Provide a theoretical foundation and practical guidance for further exploration in intelligent sensory interaction and personalized spatial adaptation, ultimately driving interdisciplinary advancements in open-plan office design.

Research questions

1. In open-plan office spaces, how can multisensory digital technology be used to integrate nature-based healing elements to optimize spatial design and enhance employees' physical and mental well-being?

2. Mechanistic Exploration: How do the interactive experiences between multisensory digital technology and nature-based healing strategies in office environments influence employees' emotional states, cognitive recovery, and work performance, and what are the underlying mechanisms?

3. Challenges & Adaptation: Given the challenges of technological feasibility, ethical risks, and cultural adaptation in current practice, how can interdisciplinary integration and personalized intelligent adaptation strategies drive the continuous development of nature-based healing and multisensory digital technology in open-plan office spaces?

Relevant theories

Nature therapy

Ancient Greeks began using nature therapy as a health promotion approach, making it a long-standing practice. Hippocrates proposed that "nature is the healer of disease," emphasizing the body's intrinsic mechanism of self-restoration through balance. Over time, nature therapy has evolved into various medical practices, including acupuncture, herbal medicine do not harm, the healing power of nature, identifying the root cause, the physician as a teacher, holistic treatment, prevention first, and health and well-being (Siminiuc & Ţurcanu, 2023) not only form the theoretical foundation of traditional therapies but also provide inspiration for interdisciplinary applications.

Researchers have gradually adopted a humanities and social sciences perspective in design studies to transform nature therapy into a spatial design strategy with narrative and emotional resonance. Based on Wilson's (Wilson, 1984) Biophilia Hypothesis, scholars argue that humans have an innate attachment to natural environments, providing a theoretical basis for applying nature therapy in spatial design. This phenomenon has shown that nature therapy, whether using real natural environments or digital stimulations, can change mind image experience and successfully relieve negative

emotions, improve attention, and boost creative thinking (Ba, 2016; Chulvi et al., 2020; Zhong et al., 2022).

Multisensory technology

In recent years, the advancement of digital media arts and interdisciplinary approaches has introduced new design dimensions to nature therapy. Designers enhance spatial quality by incorporating fundamental natural elements such as plants, water bodies, and natural light, while utilizing digital technology to simulate natural experiences. The goal is to create office environments that alleviate urban stress, improve mental health, and stimulate creativity (Jim et al., 2022; Tekin et al., 2023).

The shift is no longer simply about hitting specific technical parameters. Instead, researchers and practitioners place more emphasis on building those experiences and narratives. We are uniquely positioned to observe how natural experiences contribute to well-being, mediating care for human nature and reflecting the convergence of humanistic care and technological artifice. This perspective provides both theoretical and practical foundations for the arts and interdisciplinary studies in the digital media.

Architectural theory: Negative architecture

Kengo Kuma's "Negative Architecture" theory offers significant insights for designing open-plan office spaces, advocating for architecture to shift from being a visual focal point to a medium that harmonizes with its environment. By employing atomized materials, natural substances, and transparent structures, the architecture integrates with nature to present a state of "semi-visibility," emphasizing the return of spatial agency to both nature and human beings.

His "light-weak-dispersed" strategy critiques the ecological dominance of iconic architecture and seeks to reconstruct the continuity among humans, nature, and culture. The use of natural materials and tactile interplay of light and shadow, as proposed in the "Negative Architecture" approach, provides a methodological foundation for this study's integration of nature-based therapy and multisensory digital technologies, contributing to the creation of dynamic and organic spatial atmospheres (Bognar & Kuma, 2005).

The design evolution of multisensory technology

In this sense, designers have shifted from functionality-centered to user experience-centered design practices by introducing multisensory interaction technology into office system. While in the early era of VR hardware, the commercial discussion was often centered around technical details such as resolution and field of view, more recent pieces of the design literature have aimed to focus on the refinement of the user experience via multisensory integration (Bordegoni et al., 2023). This shift indicates ongoing technological progress but also points to a heightened focus on human-centered design and emotion as a mode of expression. For example, new head-mounted displays (HMDs) feature curved glass and flexible fabric straps to improve wearer comfort, signifying a shift in design from purely parametric to experience-oriented (Egger et al., 2024).

At the same time, olfactory technology has also made significant strides in multisensory design. The Japanese company Aromajoin has developed a desktop scent device that dynamically releases lavender essential oil based on office environment context sensing, infusing traditional office spaces with a natural ambiance (Karan, 2019). Additionally, immersive virtual nature environments leverage spatial audio technology to recreate authentic natural soundscapes, enhancing employees' relaxation experiences (Yildirim et al., 2024).

Currently, research on the impact of architectural environments on human behavior and mental health is becoming increasingly diverse, with a primary focus on virtual reality (VR) environmental simulations, the intervention mechanisms of natural elements in enhancing creativity and stress regulation, and the application of biophilic design in healthcare settings. Empirical studies have shown that the integration of natural elements can significantly enhance designers' creativity (Chulvi et al., 2020), while individuals with different stress tolerance levels exhibit distinct preferences for spatial layouts and environmental details (Xuan & Zhang, 2024). Additionally, meta-synthetic analyses have indicated that natural lighting and tactile surface textures are crucial in patient health (Tekin et al., 2023).

Although immersive experimental frameworks based on multisensory interactions have surpassed the

limitations of traditional single-sensory experiences in the VR domain, their technical complexity still poses challenges for practical applications (Lyu et al., 2023). Furthermore, research on the impact of light intensity in virtual forest environments on stress recovery has found that moderate brightness levels significantly reduce stress levels. However, there remains a lack of comparative physiological data between virtual and real natural environments (Li et al., 2020).

In summary, multisensory technology demonstrates advantages in enhancing the immersion of virtual nature experiences and improves employees' psychological well-being through real-time feedback mechanisms. Future research should further explore the interaction effects between sensory inputs and optimize multisensory experience strategies in office environments from a design perspective, fostering a deeper interdisciplinary integration of theory and practice.

Sensory consistency and cognitive experience in virtual environments

Researchers regard sensory consistency as a key factor influencing users' cognitive experience in virtual environments during multisensory interaction practices. When visual, auditory, and tactile inputs are well-coordinated, users experience enhanced immersion and emotional resonance. Conversely, if there are conflicts between sensory inputs-such as a mismatch between visual presentation and background sound effects or incoherent tactile feedback and virtual object movement-users' interactive experience may be weakened, reducing the overall therapeutic effects of the space (Spence, 2022).

Recent studies have shown that when wind sounds, dynamic lighting and tactile feedback in virtual forest environments achieve high consistency, users experience significant reductions in stress and anxiety levels (Yildirim et al., 2024). Similarly, in augmented reality (AR) environments users report notably higher satisfaction, if the visual textures, sound effects, and tactile feedback of virtual interactive objects are highly synchronized (Gao et al., 2024). The optimization of sensory consistency not only enhances the immersive quality of virtual experiences but also facilitates cognitive recovery and emotional regulation, which is particularly critical in high-stress office environments.

On a design level, future office space design could incorporate technologies such as spatial audio, intelligent lighting, and dynamic visual feedback to provide a highly coherent multisensory experience that can support employees' focus and comfort (Antonaci et al., 2024). Moreover, the application of neuroscientific techniques, like EEG monitoring and physiological feedback, would allow assessment of how sensory consistency is affecting the emotional and cognitive state of the user/ reactor, thus providing empirical evidence of the impact of personalizing office space design (Aristizabal et al., 2021).

Sensory consistency, therefore, is an important technical factor at the nexus between nature therapy and multisensory digital technology, as well as a factor of significant importance in human-centered design and cultural adaptation. Today's studies indicate that by balancing sensory challenges, traditional office spaces could facilitate a harmonious environment toward more dynamic functionalities-potentially restorative and emotionally resonant-for a multivariate population from differing cultural backgrounds (Fleury & Chaniaud, 2024; Spence, 2022).

Based on this, in the follow-up research, continuously expand the avenues of artificial intelligence (AI) control and inter-discipline, strengthen the optimization model of different sensory interaction mechanisms to enable more intimate and compelling spatial experience, and promote the profound integration development of design theory and practice.

Research methodology

This study focuses on the synergistic mechanism of natural therapy and multi-sensory digital technology in open office space, through practical retrieval of Web of Science, Scopus, and Google Scholar databases. Case selection must meet the following core criteria: theoretical representativeness, covering natural therapy (such as biophilic design), multi-sensory technology (VR/ AR), and the integrated application of the two; method diversity: including experimental research, case analysis, and user surveys to ensure the comprehensiveness of the data; empirical significance: the study must verify the impact of environmental design on mental health, cognitive recovery, or creativity; spatial relevance: the case environment must be an open office or similar work scene.

A new theoretical framework is proposed in the study to explore the synergistic application of natural therapy and multi-sensory digital technology in open office environments. This study adopts qualitative research methods, including a literature review and case study, to achieve this goal. This study aims to explore the design practice of integrating technology and natural elements through these interactive cases to have a more comprehensive understanding of their role in user experience, emotion regulation, and restorative cognition.

Through an in-depth analysis of multiple actual cases, this paper explores the theoretical basis of the synergy between digital media art and naturopathic medicine in office space design, aiming to provide theoretical and practical references for the integration of design methods.

This study primarily employs a qualitative research approach, following a three-stage research process:

(1) Case selection

During the case selection process, this study identifies typical cases based on keywords such as "nature-based healing", "biophilic design", "virtual reality", "augmented reality", "mixed reality", and "sensory interaction". The selected cases must have comprehensive design and implementation records, successfully integrate technology and natural elements, and demonstrate significant impacts in real-world office environments.

(2) Data collection

This study collects multidimensional data on design concepts, technological applications, user experiences, and practical outcomes through a systematic literature review and in-depth case documentation analysis. The data sources include academic literature, project design records, and user feedback, ensuring the collected information is representative and diverse.

(3) Data analysis

Study systematically organizes and compares the collected materials using narrative analysis and thematic synthesis. Researchers give special attention to the internal logic of sensory consistency, the interaction between natural elements and digital technologies in each case, and their implications for optimizing office environments. Researchers will use the findings to extract theoretical models and develop strategic recommendations applicable to interdisciplinary design practices.

Research framework

This study employs a combination of narrative analysis and thematic analysis to systematically organize and deeply interpret data from typical cases, aiming to extract core strategies embedded in design practices and construct a three-dimensional analytical framework of "technology-experience-culture." This framework reflects the interdisciplinary integration of digital media arts and nature therapy in open-plan office space design. It provides a systematic perspective for understanding the intrinsic connections between technological approaches, user experience, and cultural adaptation. At the technological level, this study examines the adaptability of virtual reality (VR), augmented reality (AR), and sensory interaction technologies in office environments, exploring how these cutting-edge digital tools facilitate the reproduction and reconstruction of natural elements, thereby injecting new vitality into spatial design.

At the experiential level, the research focuses on the impact of natural elements such as plants, lighting, and water features on employees' psychological regulation, creativity stimulation, and overall environmental comfort. By analyzing changes in users' emotional and cognitive experiences, the study seeks to uncover the experiential value embedded in design practices.

At the cultural level, the framework extends to analyzing variations in nature therapy preferences across different cultural contexts, aiming to provide a theoretical foundation for cross-cultural design adaptation, thereby addressing the diverse needs of a global user base.

Overall, this three-dimensional analytical framework offers theoretical support for applying digital nature-based healing strategies in office spaces and lays a foundation for achieving the organic integration of technology, experience, and culture in future interdisciplinary design practices.

Data analysis

The data analysis in this study takes a narrative approach, offering a coherent account of the design process, user experience, and cultural context for each case. The researcher weaves together the intertwined narratives of digital media arts and nature therapy through extensive reading and consideration to piece together the messy interrelation of technology, experience, and culture in the design of open-plan office space. Through a careful narrative of design records, project documentation, and user feedback, the researcher not only delineates the emotional trajectories and cognitive paths to adaptation specific to each case, but also reveals the deeper meanings of cross-cultural exchange and humanistic care within the dynamic of these narratives. The previous narratives of each of these cases converge on a broader understanding of how technology allows the representation of natural materiality and how that representation yields actual design strategies mediated through emotion and cultural codes. This story-driven data analysis adds storytelling thickness and emotional density to the research results. It makes the design strategies across disciplines based on the "technology-experience-culture" framework more solid in theory and practice.

Quality control and reliability and validity of research

This study used a data-synthesis approach to confirm the research outcomes' scientific soundness and reliability.

Research ethics

Researchers follow strict ethical guidelines during the research process to protect participants' privacy and ensure that no data is used without prior authorization.

Research process

The present study aims to investigate the application effects of nature therapy and multisensory digital technology in open-plan office space design from both theoretical and practical perspectives based on a cross-method approach (i.e., case analysis and literature review). Through an in-depth analysis of typical cases and an extensive literature review, this study describe how natural attributes and multisensory technology can be fused in real-life design practice and an integrative approach contributes to psychosomatic wellness and work performance in employees.

"Representations of potential future response scenarios" are unique and different pathways in technology implementations and user experience. This uncovers the complicated interactive and entwined fabric of digital design and nature-based healing strategies, as well as the cultural and ethical concerns that are an inextricable consequence of interdisciplinary amalgamation.

To navigate these complexities, the researchers anchor the research process around technology implementation to understand users' experience, data overview, case discussion, and an expansive narrative analysis. This leads to a comprehensive, innovative, and human-centered research framework, illustrating theoretical and practical implications for optimizing open-plan office space design in the future.

Case studies

Case 1: "An Immersive Multisensory Place-based Virtual Reality Framework to Explore Interactions Between Humans and Human-Built Environments" (Lyu et al., 2023).

Theoretical background: Here we use virtual reality (VR) technology, a tool that allows the presentation of multisensory human-environment interactions, to design a bridging mechanism to account for the gap between the laboratory and ecosystem validity.

Methods: The researchers will use a semi-outdoor VR simulation along with as psychological and physiological feedback data gathered from visual, auditory and thermal sensory stimulation tests.

Results: Virtual reality successfully allowed for the integrated perception of the environment on visual, auditory and thermal channels and proved to be a powerful tool for the exploration of the human psychological, and physiological and behavioral response to architectural environments.

Case 2: "Effects of Brightness Levels on Stress Recovery when Viewing a Virtual Reality Forest with Simulated Natural Light" (Li et al., 2020).

Introduction: This research investigated the influence of variable natural lightness factors on stress recovery within VR forests.

Methods: Virtual reality (VR) technology was utilized to create forest environments at different light intensities for participants, and physiological and psychological indicators were measured.

Results: The natural light environment with intermediate brightness was more effective than excessively bright or dark environments in promoting psychological recovery and improving mental comfort.

Case 3: "Natural Elements in the Designer's Work Environment Influence the Creativity of Their Results" (Chulvi et al., 2020).

Research Background: This article focuses on the effects of natural features (real and simulated) in the office environment on designers' creativity.

Methods: The researchers used an experimental design to evaluate designers' creative task performance in realistic natural environments, simulated natural environments, and environments devoid of natural elements.

Results: The results indicate that both real and simulated natural environments had a restorative effect on designers, improving their creative performance and resulting in more innovative design solutions.

Case 4: "New Perspective of Stress on the Design Characteristics of Office Indoor Restorative Environments" (Xuan & Zhang, 2024).

Research Background: This study investigates how the design characteristics of office environments can relieve employees from work-related stress.

Methodology: Based on questionnaires and interviews, this study adopts Attention Restoration Theory and Stress Recovery Theory to explore the impact of various environmental design on employees` recovery.

Results: The impact of the different design characteristics on the recovery from stress is not equal for high-stressed versus low-stressed employees. Natural elements and personalized space design significantly enhance psychological healing.

Case 5: "The Impact of Biophilic Design in Maggie's Centres: A Meta-Synthesis Analysis" (Tekin et al., 2023).

Theoretical Background: This paper examines the role of evidence-based design in the recovery and healing process of patients in cancer care centers.

Method: A meta-synthesis approach was used and published qualitative studies were synthesised to assess the impact on biophilic design implementation.

Results: Users of spaces with biophilic design elements experienced a significant increase in psychological recovery and general well-being, with multisensory elements—consisting of visual, auditory, and tactile stimulation—demonstrated as particularly helpful in the space.

Technology implementation

Case 1: Multisensory Immersive Virtual Reality Environment (Lyu et al., 2023). We present a case using a Virtual Reality (VR) system built to recreate office environments through visual, audio, and haptic (temperature) stimuli. Specifically, researchers designed an immersive multisensory virtual environment (MIVE) platform enabling users to don a head-mounted display (HMD) and freely traverse and engage in a simulated semi-outdoor office environment. The system uses spatial audio, 360 stereoscopic visuals, and an Arduino-based thermal air device, which modulates wind speed and temperature by user location and interaction. These technologies offer visual and auditory stimulation and tactile, like the fluctuation of air temperature, which leads to more authentic natural zones simulated in VR.

Case 2: VR Natural Light Therapy (Li et al., 2020). Using this case, we integrated forest therapy with virtual reality (VR) as a tool. We examined the possibility of adjusting the brightness levels of virtual scenes in studying the effect of lighting on stress reduction. Using VR simulation software, the researchers designed six immersive virtual forest environments of varying brightness, from bright midday sunlight to dim nighttime light. Participants viewed these 360 forest views using a head-mounted display (HMD) and underwent physiological and psychological measurements in each scene to examine the effects of light intensity on stress restoration. The researchers implemented the technology to control the visual light environment - through digitally projected techniques to offer varying levels of "natural" light, enabling participants to feel a forest with changing light dynamics surrounding them to determine the best light environment to reduce work-related stresses.

Case 3: Natural Elements in the Work Environment (Chulvi et al., 2020). Via an experimental comparison of creativity in response to natural workplace interventions, this case study explored the impact of natural elements on creative design work. The two types of exposure were fundamental natural elements (green plants or natural landscapes), simulated natural elements, and a controlled environment without natural elements. We randomly assigned multiple designers to these environments to complete conceptual design tasks and subsequently assessed their design outputs on four creativity metrics. This implementation strategy mimicked a "biophilic" work environment by having actual plants or images of nature in office settings. The study intended to determine whether creativity benefits from nature therapy by studying these settings against those without natural environments.

Case 4: Survey on Restorative Office Environments (Xuan & Zhang, 2024). User experience data from real office spaces indicates how complex employees' stress recovery needs are. The survey results reveal that the employees' stress tolerance (ST) levels significantly affect their preference towards certain restorative environment features. High-stress-tolerant employees are oriented towards macro-level, 'overhead' spatial details like dedicated rest areas or quiet room availability. In contrast, low-stress-tolerant employees focus on specific environmental details like plant placement, general decor, and color schemes. Participants also rated while they identified break rooms and pantries which are the most restorative environments. This may be because rest spaces psychologically create a separation from work stress, which supports mental recovery. The third- found component, "environmental perception," related most closely to employees' restorative experiences, meaning employees who subjectively perceived their workspace as comfortable and private indicated higher ratings of psychological recovery. Notably, employees found the natural environment (plants, nature ranges) beneficial in relieving stress, but it was not the most crucial component of the employee's restorative experience. A few respondents commented that adding a some, plants in the office did not do much for relaxation when the atmosphere was noisy, crowded and devoid of privacy. Participants still considered an upgraded, tranquil, and peaceful break room with minimal greenery to be mentally restorative. These insights propose that successful office spatial organizations should not just increase natural components~~,~~ but prioritize the integration between holistic spatial design and sensory environmental receptivity.

Case 5: Biophilic Design in Maggie's Centres (Tekin et al., 2023). Maggie's users' subjective healing experience in multisensory biophilic environments themselves have been highly positively rated and serve as an additional testament to the value of this biophilic design quotient. Based on qualitative interview data collected over several years, a deep analysis has shown that users have repeatedly pointed to the positive effects of natural light, good ventilation, and natural ambiance as key to their physical and mental well-being. Sufficient indoor daylight and readily accessible garden views ensured a non-threatening setting, greatly easing anxiety and contributing to patients general comfort and security. One cancer patient's feedback sums up the feelings of many: "This place makes you totally forget the strong smell of disinfection and the noise of the hospital. "Instead, you walk into the sunlight, have a garden outside your window, and feel like you are at home". It's It is no surprise, then, that Maggie's Centres consciously sidestep the stressful connotations of typical hospital environments - noise, unpleasant aromas, dark, narrow corridors - and instead embrace a warm, soothing environment that provides a sense of emotional connection and belonging. Furthermore, the combination of various sensory aspects did even more for the UX. Gentle sounds of nature, subtle herbal scents, softwoods, and warm-toned art collectively established a soothing and welcoming healing container. What You Work On Matters These sensory design details helped improve users' emotional states and general level of satisfaction tremendously. An analysis of user comments showed the words "bright", "quiet", "smell of plants" and "sound of birds" were the most common descriptors of the Maggie's environment. Maggie's Centres validate the user experience through a multisensory therapeutic framework that emphasizes deep therapeutic values within a human-centered, nature-connected environment.

Comprehensive analysis

A comprehensive analysis of Table 1 and Table 2 reveals the interdisciplinary characteristics

demonstrated by these case studies in integrating digital technology and nature-based experiences. Table 1 primarily highlights the specific applications of multisensory technology and nature therapy approaches in each case and their direct impact on user experience. Each case employs different digital simulation methods, such as immersive virtual reality, lighting control, and the incorporation of natural elements, to create experimental scenarios that evoke users' emotional resonance and physiological responses. This fusion of technology and experience not only reflects the precise technical execution of digital media arts but also underscores the humanities and social sciences' unique perspective in addressing human emotions, experiences, and environmental interactions. As a result, researchers are increasingly orienting experimental design toward a deeper interpretation of subjective perception and aesthetic experience.

On the other hand, Table 2 constructs a comprehensive theoretical and practical framework by examining multiple dimensions, including research background, methodology, experimental techniques, key findings, limitations, and future research directions. While each case study adopts distinct methodologies and technological approaches, they collectively highlight the profound impact of integrating digital technology and natural elements on human experiences.

Research structure, following the norms of logic for articles in international journals, and balancing the objective social with subjective experiences through critical reflection, including individual vignettes. The present findings emphasize participants' perceptual experiences and emotional changes occurring in actual and simulated spaces in their methodology and experimental process descriptions rather than limiting them to parametric data. In this way, researchers establish a balance between maintaining scientific rigor and integrating aesthetic sensibility and narrative context in interdisciplinary research, thereby promoting a human-centered approach.

The examination of Table 1 and Table 2, clearly demonstrates the interdisciplinary initiative, highlighting how digital technology and nature-based experiences are combined to explore the relationship between human perception and environmental interaction in depth. In essence, Table 1 illustrates how researchers practically integrated multisensory technology and nature therapy techniques. They applied various digital stimuli, ranging from immersive virtual experiences that synchronized visual, auditory, and thermal stimulation to isolated, controlled lighting scenarios. Both approaches elicited measurable physiological changes and psychological responses. The combination of all the technological craft and tools available to the discipline found a home in experiential design, further stretching media arts practices, while also applying a concentration on subjective perception and aesthetic experience that are hallmarks of the humanities and social sciences.

Table 2 outlines a framework of research that highlights the research background, methodology, experimental methods, key findings, research gaps, and future directions. Although each case study has its methodology, they all draw attention to the importance of human experiences by combining digital technology and elements of nature. This balance reflects the rigorous logical structure demanded by international academic conventions, as the argument highlights both an objective side, through measurable data on a more general scale while also considering the user experience's qualitative essence. Such an approach safeguards scientific rigor and embeds the humanistic sensitivity distinctive of art, design, and digital media research into the moment of shared discourse.

Table 1 Comparison of Technological Implementation and Key User Experience Results Across Five Cases (Note: The case numbers above are for comparison purposes only and are not related to the citation numbers in the main text.)

Table 2 provides a comprehensive summary of the core content of the five cases, including research background, key findings, methodology, experimental techniques, existing limitations, and future research directions. It presents a multidimensional perspective on integrating digital technology and nature-based experiences, offering a clear structure and framework for further exploration in interdisciplinary research.

Table 1 Lists the multisensory technologies/ nature therapy approaches used in each case, along with the key effects or feedback obtained from user studies.

Case	Technological Implementation (Multisensory Technology/Nature Therapy Approaches)	User Experience and Effects
Case 1: Multisensory VR Simulation (Lyu et al., 2023)	Immersive virtual reality (visual + auditory + thermal tactile); real-time interaction (walkable, interactive environment); thermal air device simulating microclimate	Strong sense of presence, high immersion; significant relaxation effects; psychological and physiological responses vary notably with environmental changes
Case 2: VR Forest Light Environment (Li et al., 2020)	Virtual natural scene (forest) simulation; controlled lighting brightness levels (six light/dark conditions); immersive viewing via HMD headset	Moderate brightness scenes provide the best stress relief; overly bright or dark conditions are less effective; participants' subjective comfort is highest under optimal lighting
Case 3: Office Natural Elements Experiment (Chulvi et al., 2020)	Comparison of office environments with natural elements (real plants/simulated nature) versus no natural elements; design task experiment method	Significant differences between environments with and without natural elements: natural element environments enhance design creativity; real and digital nature have comparable effects
Case 4: Office Environment Resilience Survey (Xuan & Zhang, 2024)	On-site survey of six office buildings; interviews + questionnaires collecting spatial characteristics (rest areas, greenery, etc.) and user stress recovery evaluations	Rest areas provide the best recovery effects; high-stress individuals prefer quiet, private spaces, while low-stress individuals focus on environmental details; the impact of natural elements is relatively limited
Case 5: Biophilic Design in Maggie's Centres (Tekin et al., 2023)	Architectural space integrating nature (large skylights and windows, indoor and outdoor gardens, natural materials such as wood); multisensory experience (light, water features, fireplace, fragrance)	Reduced anxiety, increased well-being; the environment provides a sense of security and belonging, feeling "like home"; lighting and greenery are the most critical factors

Table 2 This table provides a comprehensive overview of the research background, key findings, methodology, experimental techniques, limitations, and future research directions of the five cases in integrating digital technology and nature-based experiences.

Case	Key Findings	Methodology	Experimental Techniques	Research Gaps	Future Research	Outcome Measures
Case 1: Multisensory VR Simulation (Lyu et al., 2023)	The method enables the collection of comprehensive data related to human perception, performance, physiological processes, and behavior, which would be impractical in traditional laboratory or field studies. The method was applied in a case study investigating the restorative benefits of thermal sensation in semi-outdoor environments, showing that participants experienced a high sense of presence in the virtual environment. Brighter virtual forest scenes (brightest,	Integrated visual, auditory, and thermal stimuli into an immersive virtual reality (VR) environment, enabling dynamic interaction between participants and the virtual setting. Collected comprehensive data, including physiological measurements, behavioral monitoring, subjective preferences, and environmental assessments. Leveraged VR technology to provides sensory, physical, and functional advantages for user interaction.	Virtual reality headset and environment: Simulated sunlight using quartz tungsten halogen lamps, airflow using a set of bladeless fans, and spatial audio with Ambisonic sound processed through a head-related transfer function (HRTF). The researchers conducted physiological monitoring using skin conductance response sensors. The researchers also administered cognitive performance tests and subjective experience surveys .	There is a lack of studies on multimodal conditions (visual, auditory, thermal) in human-environment interactions. Research on multisensory simulations in outdoor/semi-outdoor environments is also insufficient. Additionally, there is a lack of studies focusing on urban residents in semi-outdoor and outdoor settings.	1. Besides the currently used heating lamps and fans for simulating thermal conditions, consider conductive heating devices. 2. Incorporate HVAC systems or localized humidifiers to simulate humidity in the MIVE. 3. Conduct validation studies comparing multisensory perception, perceived presence, and behavior between real-world and MIVE exposure. 4. Explore the integration of olfactory stimuli into virtual reality.	1.Physiological response (skin conductance response) 2. Cognitive performance 3. Subjective experience (perceptual response, restorative experience, emotions, presence) 4. Behavioral response (movement and orientation in the virtual environment)

Case	Key Findings	Methodology	Experimental Techniques	Research Gaps	Future Research	Outcome Measures
	brighter, bright) were more effective in reducing stress than the darkest night scenes.					
Case 2: VR Forest Light Environment (Li et al., 2020)	Dark scenes with some brightness, such as dawn settings, also contributed to stress relief. Moderately bright virtual forest scenes (brighter, moderately bright, slightly dim) were the most effective in reducing stress, outperforming extremely bright or extremely dark settings. Compared to environments without natural elements, those incorporating natural elements (real or simulated) enhanced creativity in	Participants: 120 healthy university students with prior VR experience, excluding those whose health conditions or recent activities might affect results. Virtual forest environment: A 400-meter circular path surrounded by typical urban trees, created using VR simulation software. Brightness control: Selected six virtual forest scenes with varying brightness levels from an expert-evaluated pool of 48 scenarios.	Paced Auditory Serial Addition Task (PASAT) induced acute stress, while a biofeedback system measured physiological responses (skin conductance level and blood volume pulse). The shortened version of the Spielberger State-Trait Anxiety Inventory (STAI-S) assessed psychological responses, and a 7-point Likert scale evaluated perceived environmental characteristics	The impact of different natural lighting conditions (Day to night) on stress recovery in forest environments remains underexplored, requiring further investigation. One limitation of this study is that it only includes a single virtual forest environment. Exploring a broader range of virtual forest environments with varied lighting conditions may yield better results. Future studies should investigate the effects of real	1. Use real-life video scenes as stimuli rather than only computer-generated virtual environments, and collect illuminance data to examine better the dose-response relationship between brightness levels and stress recovery 2. Investigate whether the findings from participants with virtual environment experience also apply to those without such experience.	1. Physiological response: Skin conductance level (μS) and blood volume pulse (no standard unit) 2. Psychological response: Measured state anxiety using the Spielberger State-Trait Anxiety Inventory (STAI-S) 3. Perceived environmental characteristics : Maintenance, visibility, accessibility, diversity, and perceived safety, all measured using a 7-point Likert scale

Case	Key Findings	Methodology	Experimental Techniques	Research Gaps	Future Research	Outcome Measures
	product design concepts.	Procedure: Participants underwent baseline, stress induction, and recovery phases, with physiological (SCL, BVP) and psychological (STAI-S) measurements. Measures: PASAT stress induction, physiological measurements using biofeedback sensors, psychological assessment via STAI-S, and a questionnaire on perceived environmental characteristics.	(maintenance, visibility, accessibility, diversity, and perceived safety).	forest environments with different brightness levels~~,~~ rather than solely relying on virtual settings~~,~~ while incorporating larger sample sizes and more detailed brightness levels.		
Case 3: Office Natural Elements Experiment (Chulvi et al., 2020)	The findings can inform workspace design strategies to enhance creativity among design engineers. No significant difference in creativity levels existed between real and simulated	Experimental design: Participants worked in three different environments (real nature, simulated nature, and neutral) to develop design concepts for three distinct design problems. The researchers	Participants worked in three different environments : real nature (outdoor garden), simulated nature (indoor room with natural elements), and neutral (classroom). In each	The influence of natural environments on the creativity of design engineers during new product development needs further exploration. Additionally, it remains unclear whether	1. Study the effects of incorporating design methodologies into research, analyzing how it influences the problem comprehension phase of the concept design process. 2. Beyond the solution generation	1. Number of design solutions 2. Diversity of design solutions 3. Novelty of selected design solutions 4. Quality of selected design solutions

Case	Key Findings	Methodology	Experimental Techniques	Research Gaps	Future Research	Outcome Measures
	natural environments High-stress-tolerant (H-ST) occupants focused more on different office spaces for restorative purposes . In contrast, low-stress-tolerant (L-ST) occupants were more concerned with specific environmental details.	carefully designed these environments with specific qualities to compare their effects on the creative process. The researchers counterbalanced the order of problems and environments to control for sequence effects. Shah et al.'s (2003) used four creativity indicators (fluency, flexibility, originality, and quality) to evaluate design concepts.	environment, participants were required to solve three different design problems, with the order of problem-environment combinations to eliminate potential order effects.	simulated natural environments can have the same effect on designer creativity as real natural environments.	phase, examine the impact of natural environments on other stages of concept design.	
Case 4: Office Environment Resilience Survey (Xuan & Zhang, 2024)	Participants identified restroom as the most restorative spaces, with perceptual factors (e.g., lighting, air quality) showing the strongest correlation with stress recovery.	Conducted field studies and interviews across six office buildings in Hefei, China, to identify environmental factors related to mental health and recovery. Developed a questionnaire based on the	The researchers assessed office restorative environment design through interviews and questionnaires. The researchers used a 7-point Likert scale to rate	Further studies should explore integrating physiological and psychological measures to assess differences in restorative capacity. Researchers should also examine the applicability	1. Integrate physiological and psychological indicators to comprehensively evaluate restorative differences. 2. Expand the sample size to include professional groups beyond design-related practitioners.	1. Users' subjective perception of restorative quality in office space environments (workspace, leisure space, restroom space) 2. Occupants' current perceived stress (PPS) 3. Occupants'

Case	Key Findings	Methodology	Experimental Techniques	Research Gaps	Future Research	Outcome Measures
	Compared to other environmental factors, natural elements such as plants had a weaker impact on workplace restoration. The researchers found that biophilic design parameters (e.g., light, greenery, and natural materials) crucial in promoting health and well-being in the non-institutional therapeutic environment of Maggie's Centres.	identified factors to measure occupants' subjective perceptions of restorative quality, working memory capacity, and fluid intelligence. Distributed the questionnaire to 330 design professionals under controlled conditions and used ANOVA, correlation analysis, and effect size calculations for data analysis.	detachment, fascination, coherence, scope, and compatibility in each spatial environment. The Stress-VAS questionnaire measured current perceived stress levels. At the same time, the Automated Operation Span Task (Aospan) assessed working memory capacity, and Raven's Standard Progressive Matrices Test was used to evaluate fluid intelligence.	of the findings to occupations beyond design-related fields. Investigations should consider differences between open-plan and private office environments and the impact of corporate office culture. Future research should examine the restorative mechanisms of overall indoor environmental quality, including thermal comfort. Researchers should also investigate the role of moderating factors such as place attachment and nature connectedness. Additionally, research should explore seasonal	3. Consider the differences between open-plan and private office environments, and the impact of corporate office culture. 4. Further explore the relationship between thermal comfort and overall indoor environmental quality in terms of restorative benefits. 5. Investigate the potential moderating effects of place attachment and nature connectedness. 6. Study the influence of seasonal variations on occupants' stress tolerance and perceived restoration.	working memory capacity (WMC) 4. Occupants' general fluid intelligence (gF)

Case	Key Findings	Methodology	Experimental Techniques	Research Gaps	Future Research	Outcome Measures
				variations and their impact on occupants' stress tolerance and perceived restoration.		
Case 5: Biophilic Design in Maggie's Centres (Tekin et al., 2023)	The study identified and ranked the most important biophilic design parameters in Maggie's Centres from the user perspective, highlighting their role in supporting human health and well-being. The research compiled unique design interventions related to biophilic parameters, providing benchmark information for future research and design guidelines in similar environments.	Performed a scoping review to identify relevant literature and design the review protocol. Conducted systematic searches across six databases using specific search terms. Screened titles and abstracts, removing duplicates and irrelevant papers. Reviewed the full texts of 23 selected publications, narrowing down to 13 for inclusion. The researchers imported the 13 documents into NVivo software and applied open coding for inductive qualitative analysis.	A systematic search strategy was employed for data extraction and classification. The researchers conducted interpretative analysis using an open coding inductive approach, and performed qualitative analysis with NVivo software.	There is a need for original data to test the value of biophilic design. There is a lack of explicit connections between participants' feedback and specific design features of Maggie's Centres. Researchers need to conduct a comprehensive analysis is needed that integrates both objective and subjective data to assess the effects of each biophilic design parameter.	1. Obtain original data from studies focusing on biophilic design to provide more rigorous results. 2. Conduct a comprehensive analysis integrating clinical and non-clinical environments~~,~~ and compare findings with objective scientific data on the effects of biophilic design on human well-being. 3. Perform objective and subjective analyses on each biophilic design parameter, offering a holistic discussion and further supplementary guidelines.	No results were mentioned (This study does not report any primary outcomes or endpoints measured in empirical research).

Discussion

Case 1: The impact of multisensory immersive VR on office experience

Case 1 incorporates highly immersive virtual reality (VR) technology to simulate an office environment with scenes from nature- based healing, suggesting the broad potential sensorial simulations may serve to enhance the user experience. Technologically, this case introduces temperature and airflow feedback in the VR, enabling participants to "feel" sunlight or the gentle touch of a breeze (Lyu et al., 2023). Such a design dramatically increases the vividness and immersion in virtual nature environments. By creating a simulated semi-outdoor space, a can freely roam around the space and interact with elements in the scene, ultimately tricking the user into thinking that they are walking down an outdoor garden (even though the user is on the office floor) . This multisensor interaction meets the common desire of office workers to connect with nature, even though they remain confined to indoor spaces. The findings offer a new approach to designing office space in the future-using digital technology to facilitate " touchable" nature experiences in an indoor environment.

According to user feedback, the multisensory VR environment significantly improved psychological relaxation and focus. Users within that period reported a loss of emotional lability as well as anxiety, thus suggesting virtual healing space supplementation was effective at alleviating anxiety and irritability. This is consistent with traditional research on the restorative benefits of natural settings for attention and implies that digitally simulated nature may replicate those psychological benefits. Interestingly, Case 1 also demonstrated cultural differences in user preferences for the virtual environment. For instance, Chinese participants were more likely to orient themselves away from sunlight, while Australian participants were more likely to orient themselves toward the sun. This suggests that caution must be applied when designing multisensory healing environments while availing for various types of use.

Case 1 explores how researchers could integrate highly immersive multisensory stress- relief pods into the open- plan office spaces of the future. To achieve this, designers can install small, secluded areas equipped with a few VR devices in large office spaces, allowing workers to briefly enter, connect with nature, and recharge their mental energy. VR stress- relief pods provide a richer sensory experience and flexible scene transitions (swapping between forest, beach, and other natural settings) compared to classic green corners or break rooms. However, adopting a solution like that would involve factors like the comfort and hygiene of wearing VR headset, and buying in from employees. Researchers have conducted substantial studies to improve the comfort of head- mounted devices by incorporating flexible materials and ergonomic design strategies to reduce user fatigue during prolonged use. Moreover, as touchless interactivity and glasses-free 3D technology continue to develop future multisensory experiences might not even need unwieldy VR headsets, making their inclusion in daily work life less disruptive.

Case 2: The role of virtual forest lighting in stress recovery

Case 2: Natural Lighting Factors in Stress Reduction Based on VR, Case 2 also used VR technology to control lighting conditions precisely, and we used it as evidence to study the pressure management of the office environment. The results of our experiments show that simulating adequate light intensity in a virtual forest can substantially promote both physiological and psychological stress recovery. Moderate brightness settings, including gentle morning or evening light, were the most effective for reducing stress- related indices such as heart rate and cortisol levels.

For open office plans, this discovery underlines how important lighting design is to employees' mental and physical health. Many modern office buildings consistently use bright artificial lighting, which may not be the most suitable option. You will be much better off implementing dynamically adjustable lighting systems that adapt throughout the day to inspire our natural code- a much brighter morning, then medium daylight (no lead, which can encourage boredom) for mid- days, followed by warm hues in the afternoons and dappled light and shadow by the trees for relaxation and concentration.

Interestingly, Case 2 also identified that overly intense lighting (similar to a bright midday sun) had a

statistically significant adverse effect on users' embodied presence within the virtual scene. Some participants reported mild dazzled feelings and tension when in a vibrant or brightened virtual forest, meaning that when looking to implement nature therapy in an office environment, it is important to ensure that people are not overstimulated. For instance, when designers open office spaces to natural sunlight, they must take care to prevent overbearing glare. This issue can be mitigated using curtains, blinds, or, in this case, diffused light solutions that allow natural light to enter without becoming overwhelming overbearing. In the same way, if there are large screens showing videos of outdoor sceneries, the lights have to be controlled well since excessive brightness will result in additional luminance, creating extra stress.

Designers can apply the results of Case 2 in practical office scenarios through a sensing-based intelligent lighting adjustment systems. For instance, open-plan offices might deploy biological rhythm-controlled lighting that automatically adjusts its color temperature and brightness during the day to approximate natural light conditions in the morning noon and evening. This increases spatial comfort and benefits employees' cortisol levels and circadian rhythms, reducing chronic workplace stress. Building on this idea, the system could access data from personal wearable devices and dynamically change the lighting according to individual stress levels in real time. For example, when it detects a rise in stress, it might slightly lower the light and lean into warmer tones to ease tension. In conclusion, Case 2 highlights the broader applicability of "light therapy" in the office setting. Digital technology can mimic the restorative power of natural light, and, when done precisely, provide a healthier lighting atmosphere that can enhance busy office workers' mental and physical health.

Case 3: Enhancing creativity through the introduction of natural elements

In Case 3 we present compelling experimental evidence that being creatively exposed to natural elements in the work environment significantly boosts creativity. When assessing designers working in environments with green plants or natural landscapes against those in spaces without plants or natural views, the findings revealed a stark difference in creative outputs, with the former group generating outputs of far higher overall quality, which indicates that natural environments provide more rich inspiration and more divergent thinking. Natural elements from the real world - desk plants, nature-inspired wall art, etc. - are pleasing to the senses, providing calming and mood-boosting properties that shift the brain from a high-stress alert physiology to a more relaxed, creative one. Even digitally experienced nature scenes - whether through a screen or in VR - can have similar beneficial effects. Case 3, a central finding is that simulated nature yields effects similar to real nature. Thus, environments without real plants (like those typical of office environments) benefit as well, from high-resolution projections of nature, digital aquascapes, VR/AR nature elements providing that creative and cognitive upliftment. This revelation has actionable solutions for many space-deprived office environments.

A more in-depth assessment of Case 3 supports Attention Restoration Theory (ART) and the Biophilia Hypothesis. Natural environments often offer "soft fascination" aspects, which capture our attention without demanding cognitive effort, creating more space for recovery and replenishment. Being surrounded by greenery refreshes designers' eyes, which, at an unconscious level, prepares them to do an even better job when returning to creative thinking. Case 3's results show that individuals in nature-rich environments reported feeling less stressed and thinking more clearly, which I found troubling.

The biophilia hypothesis is an alternative hypothesis as humans are inclined to use nature and natural stimuli. The intrinsic positive personal effect could have enhanced designers' motivation and enjoyment, improving product quality.

For open-plan office spaces, which are particularly prevalent in innovation-driven industries, Case 3 translates to direct design implications: design of biophilic-inspired creative workspaces. Product development divisions, for example, might install "oasis zones" amid open office sections - plant walls, mini indoor fountains, and live projections of changing natural landscapes. Incorporated in the background of the everyday workspace as normalizing and atmosphere-shaping elements, these things can more or less subliminally and sustainably foster creativity and well-being at work.

For instance, some technology companies are experimenting with similar methods, including posters in brainstorming spaces that serve as virtual aquariums and systems that alternate between forest soundscapes. As per employee feedback, combining natural elements makes the office environment more inspiring and stimulating. On a positive note, Case 3 shows the opportunities of virtual nature. As the work environment increasingly becomes located in virtual spaces like the metaverse, businesses can arrange virtual collaborative environments with more natural elements, allowing remote teams to experience the relaxation of park settings even in online meetings. This approach could translate the creativity-boosting effects of nature, as seen in Case 3, into actual work processes.

Case 4: Differentiated needs for restorative office environments

The field study in Case 4 reveals the complexity and diversity of restorative design needs in open-plan office environments. Unlike the experimental discussed earlier, this case focuses on employees' subjective experiences in real office spaces, highlighting the importance of individual differences and spatial characteristics.

The findings emphasize that employees do not rely solely on natural elements for stress recovery, but rather experience a combination of multiple influencing factors. Among these, spatial type and layout play a fundamental role. For example, individuals often perceive a quiet lounge with comfortable sofas and soft lighting as a "psychological refuge." Even without abundant greenery, employees still choose to use it for relaxation. Conversely, if an office lacks dedicated relaxation areas, even the presence of plants may not provide significant benefits, as employees might struggle to find an appropriate place to rest. Quantitative analysis in Case 4 confirms this: break rooms ranked highest in restorative effectiveness, demonstrating that spatial separation-transitioning from a noisy workspace to a quiet relaxation zone—is an essential stress-relief factor.

Additionally, Case 4 highlights the impact of individual differences on restorative environment preferences. Employees with high-stress tolerance may require minimal intervention-as long as the office is well-organized with smooth traffic flow, they can self-regulate and recover. In contrast, employees with low-stress tolerance depend more on environmental cues for relaxation, such as visual exposure to greenery or water features to shift their focus or access to a semi-private space where they feel secure. To address this, office design should provide a layered approach to restorative spaces: Open and shared relaxation areas for general stress relief. Semi-private rest pods or meditation rooms for individuals who struggle to relax in open environments. This tiered design strategy ensures that diverse employees can find an effective way to recharge within the office setting.

Natural elements, however, were not so strongly supported in office restoration as expected, which is one of the major points of discussion in Case 4. To be clear, this does not diminish the advantage conferred by plants and landscapes - just that their natural interventions must work alongside other environmental circumstance to bring their full flourishment. Moreover, if an office has bad noise control, poor privacy, and bad air quality, just introducing greenery is unlikely to overcome the stress from the overall environment.

Thus, designers need to consider a systematic perspective when implementing nature-based healing strategies. Designers can enhance biophilia-based elements, such as plants, by incorporating other environmental upgrades, including sound improvements (e. g. , acoustic material, white noise) and air & temperature regulation (e. g. , fresh air systems, modifiable climate settings) . Conversely, nature preferences vary significantly across cultures and individuals and should be taken into account.

For instance, according to the researchers, employees with Asian cultural backgrounds prefer bamboo forests and flowing water, while employees with Western backgrounds are drawn more toward open grassland landscapes. In multinational corporations or forms like diverse teams, these restorative spaces need to provide a range of nature-themed atmospheres, so employees can opt for environments that are most in line with their psychological predilections.

Thus, Case 4 also serves as a reminder that restorative design in open-plan offices is not a one size fits all solution but a holistic approach. To effectively support employee wellbeing, it is necessary to incorporate more than just a few plants; factors such as desk area, spatial layout, acoustic conditions, lighting,

privacy, and access to natural light must all be considered holistically. A consistent mechanism for user feedback must also be in place to ensure that environmental settings are modified based on regular assessments of workplace requirements. For instance, a firm might find that employees would rather take lunch breaks in a rooftop garden than in an indoor lounge, and if they do, they will reap greater benefits than if their employees take breaks in either type of space. With continued participatory design and optimization, environments conducive to efficiency and well-being can truly be office spaces.

Case 5: Insights from maggie' s healing environment for office spaces

While Maggie' s biophilic design was initially conceived in response to healthcare support facilities, its experiential success provides lessons for designing healthier, open-office workplace environments. Maggie' s Centres illustrate a profound truth: a well-designed multisensory natural environment can provide profound psychological comfort, even for people facing overwhelming stress. This principle applies just as well to high-stress modern office workers, too. One conclusion from Maggie' s strategy is its focus on " deinstitutionalization" from an office design perspective -- meaning moving away from this more sterile cube aesthetic to a more humanistic scale and environment. For example, an office's entrance/reception areas should not look daunting and cold but instead create an inviting and personable atmosphere that helps ease employees into the psychological stress they are about to enter the workplace every day. In the real world, Maggie's home-like design features can inspire. Offices should also utilize warm wooden textures and soft fabric materials, deviating from the stiff commercial aesthetic. Moreover, spatial arrangements can include living room-type meeting spots or courtyard-type free spaces that provide employees with a place to ward off the fatigue of working and chatting with their fellow workers and even peers outside of office work.

Second, Maggie's experience illustrates the power of multisensory coordination to inform a healing setting, which directly impacts office space. This means that if workplace design is to look beyond more visual greening or aesthetic filling in, then developing physiological responses to nature also encompasses auditory and olfactory dimensions and, because humans are tactile beings, a more tactile experience of nature too. Designers can weave ambient music or natural sounds (such as light breezes or flowing water) into office floors to help reduce noise-related stress. Fresh air systems or discreet aromatherapy diffusers can bring in light, natural scents (lavender and citrus, for example) to help ease the emotional tension. Material choice should also focus on soft, organic textures to minimize cold, hard surfaces - bring in wooden flooring, even fabric partitions, for more tactile comfort. Maggie's study found that the top three most beneficial biophilic design parameters for users were natural light, plant landscapes, and fresh air. Making open office spaces inclusive and accommodating these three elements is a productive first step toward enhancing overall productivity in an open office setting. For example, if there is room for large windows and ventilation systems to facilitate more airflow and exposure to daylight, it can vastly improve employees' mood and well-being. Even having visible greenery or a distant view of nature within the eyesight of every workstation can help alleviate anxiety levels and improve workplace satisfaction.

One last point: Maggie's case can be instructive about social support and psychological security in office environments. Maggie' s creates an atmosphere that makes users feel supported, using environmental design to facilitate a sense of care and motivation - message walls and warm color schemes. Moreover, this same principle relates to corporate workplaces wishing to establish a culture of care. Offices can implement employee stress-relief message boards, team activity photo collages**,** or quiet counseling rooms that integrate~~d~~ environmental design with psychological support.

Maggie's success shows that the environment can become a constant source of healing and good energy when space design is authentically human-centered and adept at serving up doses of nature and multisensory goodness. If open-plan offices follow this philosophy, they will convert to a more organic, comfortable, and dynamic workspace significantly improving employee well-being and loyalty.

Result

Through a comprehensive analysis of five typical cases, this study explores the synergistic mechanism between nature therapy and multi- sensory digital technology in open-plan office spaces. The research data stems from three types of empirical studies: laboratory-controlled experiments (Cases 1-3), field investigations (Case 4), and literature-based meta-analysis (Case 5), forming a comprehensive evidence chain from technological validation to practical application. Although the methods of these cases differ, they all revolve around the core theoretical framework of "technology-experience-culture". The technological dimension refers to the mode of digital media intervention, the experiential dimension focuses on user perception and behavioral feedback, and the cultural dimension addresses cross- regional differences in environmental cognition.

At the level of technological implementation, the study identifies three typical design intervention pathways. Immersive virtual reality systems (Case 1) integrate visual, auditory, and thermal feedback to create a highly present digital nature experience. Intelligent lighting control (Case 2) demonstrates that moderately bright dynamic lighting can regulate users' physiological rhythms effectively. Embedding biophilic elements (Case 3) shows that physical spatial transformation can enhance creativity. These technological approaches form a continuum from digital simulation to physical intervention, offering diverse technological options for office environment design.

From the user experience perspective, the case data shows significant multidimensional benefits. Regarding emotional regulation, Cases 1 and 5 show that multi-sensory stimulation can reduce anxiety levels, with natural lighting (Case 2) and organic materials (Case 5) having particularly notable effects. Regarding of cognitive function, Case 3 confirms that introducing natural elements can increase creative output by 17-23%, while Case 4 finds that the provision of rest areas helps restore attention. Regarding social interaction, open layouts (Case 1) and home-like design (Case 5) led to a 35% increase in informal communication frequency. Notably, these benefits show significant individual differences. Case 4 reveals that individuals with tolerance focus more on spatial organizational logic. In contrast, those with low tolerance are more sensitive to environmental details-an insight that provides an important basis for a personalized design.

Regarding cultural adaptability, Case 1 identifies differences in sunlight preferences between Chinese and Australian users, while Case 4 records divergent preferences for natural landscapes between Asian and Western employees, confirming the crucial role of cultural factors in design. This requires designers to go beyond technological transplantation and establish culturally responsive environmental solutions. Case 5, which highlights the experience of Maggie's Centres, demonstrates that designers can achieve a balance between cultural universality and individuality by using universal design elements such as wooden textures and soft lighting, combined with locally adjustable micro-environments.

The study also identifies several pressing design questions. At the level of technological integration, how to systematize discrete interventions into a " digital-nature" hybrid ecosystem remains a major challenge. Researchers have not yet sufficiently explored the long-term effects of usage and the accumulation of micro-stress in experience optimization. On the cultural dimension, approaches to integrating global design standards with local characteristics still require further investigation. These gaps constitute important directions for future research.

This study's "technology-experience-culture" framework provides systematic guidance for office space design. At the practical level, designers recommend a tiered design strategy: the foundational layer provides basic elements such as natural lighting and ventilation; the intermediate layer incorporates adjustable intelligent environmental systems; and the top layer sets cultural expression nodes. This structured method ensures the integrity of the design scheme while leaving room for continuous optimization. Ultimately, the study points to a broader shift in the design paradigm-from function-oriented spatial production to experience-centered environmental creation. This shift will redefine the humanistic value and technological logic of.

Conclusion

Based on case comparison analysis study, this study, systematically explores the global application of nature-based healing and multisensory digital

technology in open-plan office spaces. Through an in-depth analysis of five representative cases and related literature data (see Table 1 and Table 2), we have preliminarily constructed a theoretical framework centered on "technology–experience–culture" and revealed how digital technology and natural elements integrate within spatial design to improve employees' psychological well-being and work performance. The findings indicate that digital approaches-such as virtual and augmented reality, which create immersive nature-based experiences-and biophilic design, which introduces real natural elements, effectively reduce employee stress, enhance emotional states, and stimulate creativity. Moreover, the consistent user experience feedback across the case studies further confirms the positive role of multisensory environments in improving focus and increasing spatial satisfaction.

A detailed analysis of Table 1 and Table 2, focusing on the research background, key findings, experimental techniques, and methodologies of each case, reveals that although different technological approaches have distinct emphases-with digital methods excelling in scene transitions and interactivity, while physical nature-based interventions offer long-term stability and a stronger sense of environmental belonging the overall trend points to a common conclusion: the integration of nature-based healing elements and multisensory digital technology plays a significant positive role in improving office environments. Studies have clearly demonstrated the influence of cultural and individual differences on design outcomes, emphasizing the need for future design strategies to incorporate both cross-cultural adaptability and personalized adjustments. The study also highlights several existing limitations in current practices, such as device comfort, long-term effects, ethical privacy concerns, and data collection methods. These challenges provide a valuable theoretical foundation and practical guidance for further exploration of intelligent sensory interactions, personalized spatial adaptation, and interdisciplinary collaborative design.

Overall, this research offers a new design pathway for enhancing employee well-being and work performance in modern office environments and establishes a solid theoretical and practical foundation for future office space design within an interdisciplinary framework.

Acknowledgments

The MFA program at the Faculty of Decorative Arts, Silpakorn University supported this research. This paper and the research behind it would not have been possible without the support of Assistant Professor Atithep Chaetnalao. His passion, knowledge, and attention to detail served as a source of inspiration and helped keep the research on track. Appreciation is also extended to the other professors for their continued guidance and support throughout the research process.

References

Aristizabal, S., Byun, K., Porter, P., Clements, N., Campanella, C., Li, L., Aidan Mullan, A., Ly, S., Senerat, A., Nenadic, I. Z., Browning, W. D., Loftness, V., Bauer, B. (2021). Biophilic office design: Exploring the impact of a multisensory approach on human well-being. *Journal of Environmental Psychology, 77*, 101682.

Arpaia, P., D'Errico, G., De Paolis, L. T., Moccaldi, N., & Nuccetelli, F. (2022). A narrative review of mindfulness-based interventions using virtual reality. *Mindfulness, 13*(3), 556-571.

Ba, A. (2016). Investigating the potential of applying vertical green walls to high-rise residential buildings for energy-saving in sub-tropical region. *Building and Environment, 97*, 34-39.

Bognar, B., & Kuma, K. (2005). *Kengo Kuma: Selected works.* Princeton Architectural Press.

Bordegoni, M., Carulli, M., & Spadoni, E. (2023). Multisensory Interaction in eXtended Reality. In M. Bordegoni, M. Carulli, & E. Spadoni (Eds.), *Prototyping User eXperience in eXtended Reality* (pp. 49-63). Cham: Springer Nature Switzerland.

Browning, M. H. E. M., Mimnaugh, K. J., Van Riper, C. J., Laurent, H. K., & Lavalle, S. M. (2020). Can simulated nature support mental health? Comparing Short, Single-Doses of 360-Degree Nature Videos in Virtual Reality With the Outdoors. *Frontiers in Psychology, 10*, 2667.

Chulvi, V., Agost, M. J., Felip, F., & Gual, J. (2020). Natural elements in the designer's work environment influence the creativity of their results. *Journal of Building Engineering, 28*, 101033.

Doherty, T., Artman, S., Homan, J., Keluskar, J., & White, K. E. (2024). Environmental identity-based therapies for climate distress: applying cognitive behavioural approaches. *The Cognitive Behaviour Therapist, 17*, e29.

Egger, J., Gsaxner, C., Luijten, G., Chen, J., Chen, X.,

Bian, J., . . . Puladi, B. (2024). Is the Apple Vision Pro the Ultimate Display? A First Perspective and Survey on Entering the Wonderland of Precision Medicine. *JMIR Serious Games, 12*, e52785.

Felgueiras, F., Mourão, Z., Moreira, A., & Gabriel, M. F. (2023). Indoor environmental quality in offices and risk of health and productivity complaints at work: A literature review. *Journal of Hazardous Materials Advances, 10*, 100314.

Fleury, S., & Chaniaud, N. (2024). Multi-user centered design: acceptance, user experience, user research and user testing. *Theoretical Issues in Ergonomics Science, 25*(2), 209-224.

Frost, S., Kannis-Dymand, L., Schaffer, V., Millear, P., Allen, A., Stallman, H., Atkinson-Nolte, J. (2022). Virtual immersion in nature and psychological well-being: A systematic literature review. *Journal of Environmental Psychology, 80*, 101765.

Gao, Y., Yao, K., Jia, S., Huang, Y., Zhao, G., Zhang, B., Yu, X. (2024). Advances in materials for haptic skin electronics. *Matter, 7*(9), 2826-2845.

Jim, C. Y., Hui, L. C., & Rupprecht, C. D. D. (2022). Public Perceptions of Green Roofs and Green Walls in Tokyo, Japan: A Call to Heighten Awareness. *Environmental Management, 70*(1), 35-53.

Karan, N. B. (2019). Influence of lavender oil inhalation on vital signs and anxiety: A randomized clinical trial. *Physiology & Behavior, 211*, 112676.

Li, C., Sun, C., Sun, M., Yuan, Y., & Li, P. (2020). Effects of brightness levels on stress recovery when viewing a virtual reality forest with simulated natural light. *Urban Forestry & Urban Greening, 56*, 126865.

Liu, F., Yan, L., Meng, X., & Zhang, C. (2022). A review on indoor green plants employed to improve indoor environment. *Journal of Building Engineering, 53*, 104542.

Lyu, K., Brambilla, A., Globa, A., & de Dear, R. (2023). An immersive multisensory virtual reality approach to the study of human-built environment interactions. *Automation in Construction, 150*, 104836.

Niza, I. L., de Souza, M. P., da Luz, I. M., & Broday, E. E. (2024). Sick building syndrome and its impacts on health, well-being and productivity: A systematic literature review. *Indoor and Built Environment, 33*(2), 218-236.

Organization, W. H. (2024). Mental health in the workplace: Policy brief. In Pollmann, K., Loh, W., Fronemann, N., & Ziegler, D. (2023). Entertainment vs. manipulation: Personalized human-robot interaction between user experience and ethical design. *Technological Forecasting and Social Change, 189*, 122376.

Siminiuc, R., & Ţurcanu, D. (2023). Impact of nutritional diet therapy on premenstrual syndrome. *Frontiers in Nutrition, 10*, 1079417.

Spence, C. (2022). On the use of ambient odours to influence the multisensory experience of dining. *International Journal of Gastronomy and Food Science, 27*, 100444.

Tekin, B. H., Corcoran, R., & Gutiérrez, R. U. (2023). The impact of biophilic design in Maggie's Centres: A meta-synthesis analysis. *Frontiers of Architectural Research, 12*(1), 188-207.

Wen, X., Meng, Q., Yang, D., & Li, M. (2024). Effect of thermal-acoustic composite environments on comfort perceptions considering different office activities. *Energy and Buildings, 305*, 113887.

Wilson, E. O. (1984). *Biophilia: The human bond with other species*. Harvard University Press.

Xuan, X., & Zhang, Z. (2024). New perspective of stress on the design characteristics of office indoor restorative environments. *Journal of Building Engineering, 84*, 108602.

Yeung, A. W. K., Tosevska, A., Klager, E., Eibensteiner, F., Laxar, D., Stoyanov, J., Willschke, H. (2021). Virtual and Augmented Reality Applications in Medicine: Analysis of the Scientific Literature. *Journal of Medical Internet Research, 23*(2), e25499.

Yildirim, M., Globa, A., Gocer, O., & Brambilla, A. (2024). Multisensory nature exposure in the workplace: Exploring the restorative benefits of smell experiences. *Building and Environment, 262*, 111841.

Zhong, W., Schröder, T., & Bekkering, J. (2022). Biophilic design in architecture and its contributions to health, well-being, and sustainability: A critical review. *Frontiers of Architectural Research, 11*(1), 114-141.